

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

1. (currently amended) An apparatus for detecting a deterioration of an air-fuel ratio sensor, the deterioration detecting apparatus comprising:

air-fuel ratio sensor having an electrode on a solid electrolyte element for detecting an air-fuel ratio in an exhaust emission gas from an engine;

temperature adjusting means for adjusting a temperature of the solid electrolyte element in the air-fuel ratio sensor to at least two different predetermined temperatures, which cause a change in an output of the air-fuel ratio sensor to be larger in a normal state than in a deteriorated state; and

air-fuel ratio detection deterioration detecting means for detecting a deterioration of the air-fuel ratio sensor based on the outputs of the air-fuel ratio sensor produced when the temperature of the solid electrolyte element is adjusted to the two different temperatures by the temperature adjusting means.

2. (original) The apparatus for detecting a deterioration of an air-fuel ratio sensor according to Claim 1, wherein the temperature adjusting means adjusts the temperature and the air-fuel ratio detection deterioration detecting means detects the deterioration when the engine is in a predetermined same operating condition.

3. (original) The apparatus for detecting a deterioration of an air-fuel ratio sensor according to Claim 1, wherein the air-fuel ratio detection deterioration detecting means detects the deterioration of the air-fuel ratio sensor by comparing the outputs of the air-fuel ratio sensor relative to predetermined variations of the air-fuel ratio.

4. (original) The apparatus for detecting a deterioration of an air-fuel ratio sensor according to Claim 1, wherein the air-fuel ratio detection deterioration detecting means detects the deterioration of the air-fuel ratio sensor by comparing a response of the air-fuel ratio sensor relative to predetermined variations of the air-fuel ratio or a parameter related to an output characteristic with respect to the exhaust emission gas.

5. (original) The apparatus for detecting a deterioration of an air-fuel ratio sensor according to Claim 4, wherein the response or the parameter related to the output characteristic with respect to the exhaust emission gas is at least one of an output variation width, an output integrated value, an output differential value, an integrated value of the output differential value, an output period and an output frequency of the air-fuel ratio sensor.

6. (original) The apparatus for detecting a deterioration of an air-fuel ratio sensor according to Claim 1, wherein the temperature adjusting means estimates the temperature of the solid electrolyte element by detecting an internal resistance of the air-fuel ratio sensor and adjusts the temperature of the solid electrolyte element based on the estimated temperature.

7. (original) The apparatus for detecting a deterioration of an air-fuel ratio sensor according to Claim 6, wherein the temperature adjusting means determines an amount of heat for adjusting the temperature of the solid electrolyte element in accordance with an operating condition.

8. (original) The apparatus for detecting a deterioration of an air-fuel ratio sensor according to Claim 1, wherein the temperature adjusting means supplies or stops the heat for adjusting the temperature of the solid electrolyte element under a predetermined operating condition.

9. (original) The apparatus for detecting a deterioration of an air-fuel ratio sensor according to Claim 1, wherein the air-fuel ratio sensor is installed downstream from a catalyst.

10. (original) The apparatus for detecting a deterioration of an air-fuel ratio sensor according to Claim 1, further comprising:

temperature adjusting failure detecting means for detecting a failure of the temperature adjusting means,

wherein the air-fuel ratio detection deterioration detecting means detects the deterioration of the air-fuel ratio sensor only when the failure is not detected by the temperature adjusting failure detecting means.

11. (New) An apparatus for detecting a deterioration of an air-fuel ratio sensor, the deterioration detecting apparatus comprising:

air-fuel ratio sensor having an electrode on a solid electrolyte element for detecting an air-fuel ratio in an exhaust emission gas from an engine;

temperature adjusting means for adjusting a temperature of the solid electrolyte element in the air-fuel ratio sensor from a present temperature to at least two different predetermined temperatures, which are set for detecting deterioration of the air-fuel ratio sensor; and

air-fuel ratio detection deterioration detecting means for detecting the deterioration of the air-fuel ratio sensor based on outputs of the air-fuel ratio sensor produced when the temperature of the solid electrolyte element is adjusted to the two different temperatures by the temperature adjusting means.

12. (New) The apparatus for detecting a deterioration of an air-fuel ratio sensor according to Claim 11, wherein the temperature adjusting means estimates the temperature of the solid electrolyte element by detecting an internal resistance of the air-fuel ratio sensor and adjusts the temperature of the solid electrolyte element based on the estimated temperature.

13. (New) The apparatus for detecting a deterioration of an air-fuel ratio sensor according to Claim 11, wherein the air-fuel ratio sensor is installed downstream from a catalyst.

14. (New) The apparatus for detecting a deterioration of an air-fuel ratio sensor according to Claim 11, further comprising:

temperature adjusting failure detecting means for detecting a failure of the temperature adjusting means,

wherein the air-fuel ratio detection deterioration detecting means detects the deterioration of the air-fuel ratio sensor only when the failure is not detected by the temperature adjusting failure detecting means.

15. (New) An apparatus for detecting a deterioration of an air-fuel ratio sensor, the deterioration detecting apparatus comprising:

air-fuel ratio sensor having an electrode on a solid electrolyte element for detecting an air-fuel ratio in an exhaust emission gas from an engine;

temperature adjusting means for adjusting a temperature of the solid electrolyte element in the air-fuel ratio sensor to at least two different predetermined temperatures; and

air-fuel ratio detection deterioration detecting means for detecting a deterioration of the air-fuel ratio sensor based on change speeds of outputs of the air-fuel ratio sensor produced when the temperature of the solid electrolyte element is adjusted to the two different temperatures by the temperature adjusting means.

16. (New) The apparatus for detecting a deterioration of an air-fuel ratio sensor according to Claim 15, wherein the temperature adjusting means estimates the temperature of the solid electrolyte element by detecting an internal resistance of the air-fuel ratio sensor and adjusts the temperature of the solid electrolyte element based on the estimated temperature.

17. (New) The apparatus for detecting a deterioration of an air-fuel ratio sensor according to Claim 15, wherein the air-fuel ratio sensor is installed downstream from a catalyst.

18. (New) The apparatus for detecting a deterioration of an air-fuel ratio sensor according to Claim 15, further comprising:

temperature adjusting failure detecting means for detecting a failure of the temperature adjusting means,

wherein the air-fuel ratio detection deterioration detecting means detects the deterioration of the air-fuel ratio sensor only when the failure is not detected by the temperature adjusting failure detecting means.

19. (new) A method of detecting a deterioration of an air-fuel ratio sensor having an electrode on a solid electrolyte element, the method comprising:

detecting an air-fuel ratio in an exhaust emission gas from an engine using the air fuel ratio sensor;

adjusting a temperature of the solid electrolyte element in the air-fuel ratio sensor to at least two different predetermined temperatures, which cause a change in an output of the air-fuel ratio sensor to be larger in a normal state than in a deteriorated state; and

detecting a deterioration of the air-fuel ratio sensor based on the outputs of the air-fuel ratio sensor produced when the temperature of the solid electrolyte element is adjusted to the two different temperatures.

20. (new) The method according to Claim 19, wherein the temperature of the solid electrolyte element is estimated by detecting an internal resistance of the air-fuel ratio sensor and the temperature of the solid electrolyte element is adjusted based on the estimated temperature.

21. (new) The method according to Claim 19, further comprising:

detecting a failure of a mechanism which adjusts the temperature of the solid electrolyte element in the air-fuel ratio sensor,

wherein the deterioration of the air-fuel ratio sensor is detected only when the failure of the mechanism which adjusts the temperature is not detected.

22. (New) A method of detecting a deterioration of an air-fuel ratio sensor having an electrode on a solid electrolyte element, the method comprising:

detecting an air-fuel ratio in an exhaust emission gas from an engine using the air fuel ratio sensor;

adjusting a temperature of the solid electrolyte element in the air-fuel ratio sensor from a present temperature to at least two different predetermined temperatures, which are set for detecting deterioration of the air-fuel ratio sensor; and

detecting the deterioration of the air-fuel ratio sensor based on outputs of the air-fuel ratio sensor produced when the temperature of the solid electrolyte element is adjusted to the two different temperatures.

23. (New) The method according to Claim 22, wherein the temperature of the solid electrolyte element is estimated by detecting an internal resistance of the air-fuel ratio sensor and the temperature of the solid electrolyte element is adjusted based on the estimated temperature.

24. (New) The method according to Claim 22, further comprising:

detecting a failure of a mechanism which adjusts the temperature of the solid electrolyte element in the air-fuel ratio sensor;

wherein the deterioration of the air-fuel ratio sensor is detected only when the failure of the mechanism which adjusts the temperature is not detected.

25. (New) A method of detecting a deterioration of an air-fuel ratio sensor having an electrode on a solid electrolyte element, the method comprising:

detecting an air-fuel ratio in an exhaust emission gas from an engine using the air-fuel ratio sensor;

adjusting a temperature of the solid electrolyte element in the air-fuel ratio sensor to at least two different predetermined temperatures; and

detecting a deterioration of the air-fuel ratio sensor based on change speeds of outputs of the air-fuel ratio sensor produced when the temperature of the solid electrolyte element is adjusted to the two different temperatures.

26. (New) The method according to Claim 25, wherein the temperature of the solid electrolyte element is estimated by detecting an internal resistance of the air-fuel ratio sensor and the temperature of the solid electrolyte element is adjusted based on the estimated temperature.

27. (New) The method according to Claim 25, further comprising:

detecting a failure of a mechanism which adjusts the temperature of the solid electrolyte element in the air-fuel ratio sensor;

wherein the deterioration of the air-fuel ratio sensor is detected only when failure of the mechanism which adjusts the temperature is not detected.